The design of interlocking concrete block pavements for road traffic

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Introduction

ONE of the most interesting engineering developments in post-war Europe was the revitalization of the ancient techniques of segmental paving construction that followed the introduction of the modern, cheaply mass-produced interlocking concrete paving block.

Although the introduction of interlocking blocks grew largely out of the exigencies of European post-war reconstruction, their specialized advantages over other forms of paving made it inevitable that their use should spread far beyond Europe. By the early 1970s the use of interlocking paving had become established in the Americas. Africa. Australasia and Japan. In these countries the initial market penetration of interlocking blocks was slow, being restricted to architectural applications and the paving of pedestrian areas. This was largely the result of the lack of a suitable design method for pavements using blocks as the surface course. In this respect, the Europeans were able to call on an extensive body of experience in the use of block paving, and the lack of a proven design method was little hindrance to them. However, this European experience was neither accessible nor relevant to the new markets. For this reason research into the design of block pavements was initiated in South America[1] and South Africa[2] in the mid-1960s. This was soon followed by studies in the United Kingdom[3 4], Australia and New Zealand[5 6].

Initially most of these studies were conducted by cement or concrete marketing organizations having little expertise in road pavement design. It was not until 1977 when accelerated trafficking studies of block pavements were initiated in Australia[7 8] that the design problem was approached from the point of view of the pavements engineer. This was rapidly followed by major studies of block paving by the South African National Institute for Transport and Road Research[9] and it is encouraging to note that recently the University of Canterbury, New Zealand[10] and the Australian Road Research Board have also initiated trafficking studies of block pavements.

Thus, although research into the performance of block pavements is relatively new, a substantial body of information has already been published. The author has reviewed and critically evaluated this information elsewhere[11 12]. The purpose of this paper is to show how, by using the results of this extensive research effort, it becomes possible to derive a hierarchy of scientifically-based design methods for block paving. In this respect it should be noted that the methods presented here both supplement and supersede the design procedures published earlier by the author[13].

Design philosophy

Essentially the objective of any pavement design is to ensure a satisfactory level of performance throughout the design life of the pavement. This involves predictions of how traffic will modify the behaviour of the pavement from its original as-constructed condition. There are at least four steps involved in the solution of this problem. They are:

(i) The identification of the relevant design parameters.

(ii) The selection of suitable performance criteria.

(iii) The inter-relation of performance criteria and design parameters.

(iv) Formulation of a design methodology based on the relationship of performance to design parameters.

These steps are now considered in more detail for block pavements.

Identification and inter-relation of design parameters and performance criteria

In order to identify those parameters and criteria which are relevant to the design and evaluation of block pavements it is first necessary to obtain an understanding of how such pavements behave in service. This can only be achieved by studying full-scale block pavements under the action of actual or simulated traffic. The progress that has been made in this research area has been reported and evaluated in detail elsewhere [8 9 11 12]. Consequently, only those aspects of pavement behaviour which are crucial to the formulation of a design methodology for block pavements need to be summarized here.

Inter alia, trafficking tests of block pavements have established that:

1. In general block pavements tend to perform in a manner which is qualitatively similar to conventional flexible pavements save for a few crucial differences in behaviour listed below[7 8 9]

2. An increase in block thickness within the range from 60 to 100 mm is beneficial to pavement performance[8].

3. Under trafficking, block pavements tend to develop interlock[7 8 9 14 15]. This is manifest as increases in the load-spreading ability of the blocks and reductions in the rate of accumulation of deformation[8 9].

4. Once a block pavement constructed on a granular basecourse becomes fully interlocked it attains a stable equilibrium condition which is unaffected by either the amount of traffic[8 9] or by the magnitude of the wheel load (within the range from 24 to 70 kN)[9].

5. Once interlock has developed the blocks act as a structural layer rather than merely as a wearing course [8 9 l4]

6. Block pavements incorporating a granular base can typically exhibit elastic deflections between I and 2 mm while, at the same time, yielding only small rutting deformations[7 8].

For pavements using only granular materials in the base and sub-base courses, the implications of these findings are that, once interlock is attained, neither the amount of traffic nor the gross wheel load need be considered as design parameters. Moreover, the requirement implicit in almost all conventional flexible pavement design procedures, that the surface deflections must be limited to very small values, typically less than 0.5 mm, which will not cause fatigue cracking of the wearing course, becomes irrelevant as a performance criterion for block pavements. Consequently it may be concluded that the sole design criterion for block pavements incorporating granular bases is that the deformation which accumulates during the development of interlock be kept within suitable limits to ensure that the riding quality and drainage characteristics of the road surface are not substantially impaired. This is the basis for the

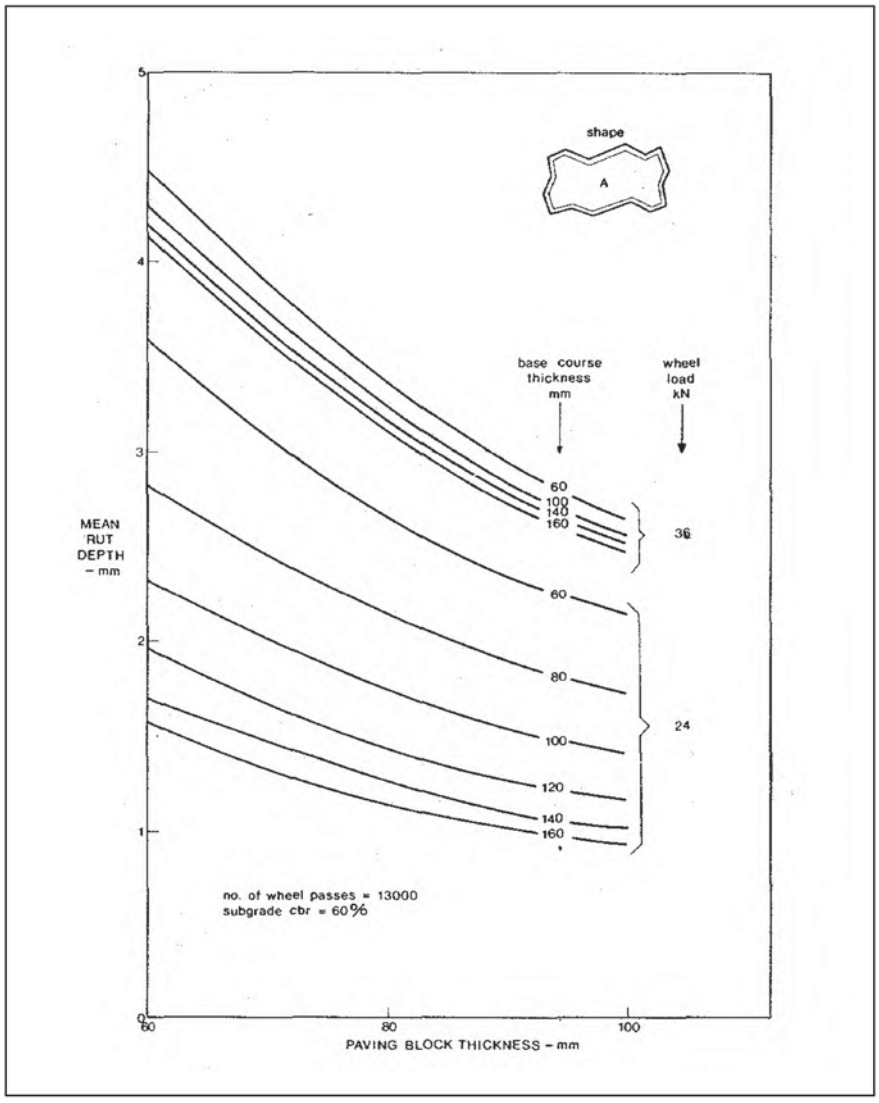


Figure 1: Rut depth as a function of block and base thickness

design methods published elsewhere by the author[13] and adopted by the Concrete Masonry Association of Australia[16].

Where a block pavement incorporates a stabilized base or sub-base it is no longer practical to tolerate large deflections in the pavement under traffic. Although, as in the case of a pavement incorporating a granular base, such large deflections are not deleterious to the blocks themselves, they may lead to the development of cracking within the base or sub-base. The consequences of this are threefold. Firstly, the stiffness (modulus) of the stabilized materials will drastically decrease. This means that more load will be transmitted to the subgrade, thereby increasing the risk of failure. Secondly, as the cracks develop, they may tend to open the joints between the paving blocks and thereby, destroy or diminish the degree of interlock. Thirdly, the cracks may facilitate the movement of rain water down through the pavement with a consequent loss of strength in the subgrade. For these reasons it is important to ensure that the deflections are limited to values which will not cause cracking during the design life of the pavement. This implies that the design must now include some measure of both load and traffic intensity. In this respect the load influences the magnitude of the deflection while the traffic intensity can be related to the amount of deflection that can be tolerated if a fatigue failure is to be avoided.

Formulation of a design methodology

Elsewhere[11] the author has categorized and critically assessed the various methods for the design of block pavements which had been described up to the end of 1979. Essentially the design procedures may be assigned to just four categories. They comprise:

I. Design on the basis of experience[5 17].

2. Ad hoc modifications of existing design procedures for conventional flexible pavements[1 3 18 19 20].

3. Mechanistic desigps based on structural analyses incorporating design parameters obtained from laboratory tests[2 14].

4. Empirical designs based on full-scale trafficking tests[13].

Except for the procedures based on trafficking evaluations of block pavements, most of the design methods have been based necessarily on conventional pavement design wisdom and have used established flexible pavement design and performance criteria. As shown above, these procedures are not always relevant to block pavements. However, the implications of using conventional design criteria have gone largely unrecognized, perhaps because the results of controlled trafficking tests on block pavements have only been available since 1978. This means that, as demonstrated elsewhere[11], many of the design methods for block pavements described to date are either unduly conservative or fundamentally unsound because they fail to account for the true response characteristics of block paving under traffic.

In an attempt to overcome these difficulties the author's design approach is based primarily upon the results of full-scale accelerated trafficking evaluations of block pavements, supplemented, where necessary, by mechanistic analyses incorporating the results of laboratory scale tests on block systems. Thus the methodology of the design procedures described here involves two distinct stages, comprising:

(i) The empirical characterization of block paving systems.

(ii) The application of mechanistic analyses to block pavements.

Each of these stages is now considered in more detail.

The empirical characterization of block pavements

The justification of an empirical approach to characterizing block pavements lies in the fact that they can be manufactured and laid to much more consistent tolerancesand specifications than most other types of flexible pavement material. Thus, the properties of a mat of paving blocks are less likely to vary from one job to another (assuming that the laying techniques are maintained consistent) than (say) a bituminous concrete surfacing. Accordingly, it can be argued that, if the properties of the mat can be characterized in one set of circumstances, such as an accelerated trafficking test, then a mat of similar blocks layed in the same manner elsewhere will have similar properties. If precautions are taken to ensure that the quality of each experimental pavement lies at the *lower* end of the spectra of qualities of materials and construction standards that can be achieved in practice, then it becomes reason-

able to apply the results of accelerated trafficking tests of prototype pavements to real situations because it would be expected that the actual pavements would exhibit somewhat higher levels of performance than the test pavements.

Adopting this philosophy the author conducted a series of accelerated trafficking tests of block pavements first in Australia and more recently in South Africa[8 9]. Here, care was taken to use basecourse materials which were towards the bottom end of the quality scale for their particular classes. Moreover, the range of basecourse thicknesses studied (60 to 160 mm) was chosen to include all thicknesses of granular base likely to be used in actual road construction while the full range of available block thicknesses (60 to 100 mm) was examined. Details of the test procedures have been given elsewhere[8 9] and need not be repeated here.

It was shown earlier that just two criteria are of importance in assessing the response of block pavements to traffic. In the case of block pavements incorporating granular bases the prime indicator of performance is the permanent or rutting deformation. By contrast, for pavements utilizing stabilized bases the principal performance criterion is the elastic deflection. The approach adopted by the author was to determine experimentally the effects of changes in the thicknesses of the paving units and of the basecourse on these performance criteria. Typical results are shown in Figures 1 and 2 for rutting and deflection respectively. These data were obtained for prototype pavements overlying a subgrade having a CBR in excess of 60%. Suitably rearranged, they form the basis of the design methods described below.

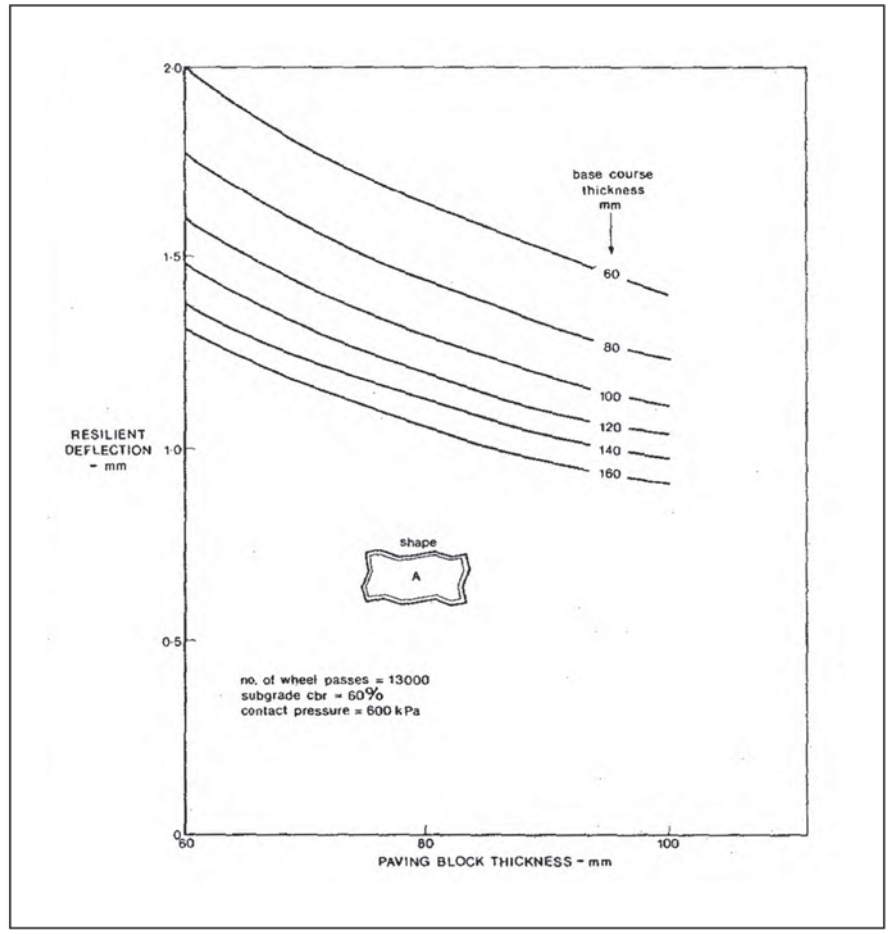


Figure 2: Elastic or resilient deflection as a function of block and base thickness

The role of mechanistic analysis in block pavement design

It would be expected that the levels of performance achieved in a prototype pavement would only be duplicated under field conditions where the in situ subgrade has a strength (e g. expressed as CBR) at least equal to that studied in the accelerated trafficking tests. Therefore, for each level of subgrade strength encountered in block pavement design it would be necessary to test a series of prototype pavements. Because of the complexity, cost and length of time involved in accelerated trafficking evaluations of pavements, it is not practical to do this. It is in this area that mechanistic analysis can play an important role.

Essentially the problem is to use the performance observed in prototype pavement on one class of subgrade to predict what pavement thickness must be used in order to achieve a satisfactory level of performance in a pavement constructed on some other class of subgrade. One simple way to accomplish this has already been described elsewhere by the author[13]. This involves the use of the well-established relationships between pavement thickness andsubgrade CBR, e.g. as described by Yoder and Witczak[21]. A study-of such relationships shows that for increases in CBR beyond 50% there is usually little significant reduction in pavement thickness. Accordingly the relationships between CBR and thickness can effectively be replotted as a series of factors, Fs,by which the thickness at a CBR of 50% or greater must be multiplied to yield the necessary depths of cover. This is shown graphically in Figure 3. Using these curves it is possible, given the thickness of pavement needed to yield a specified level of performance at some designated CBR, to calculate the thickness needed to achieve the same level of performance at some other CBR value.

Although the CBR/thickness relationships used to derive curves b and d in Figure 3 are based on a wealth of practical experience gained in the construction of conventional flexible pavements in many parts of the world, there is no direct evidence that similar relationships would necessarily apply to block pavements. For this reason it was decided to apply the techniques of mechanistic analysis to examine the manner in which basecourse thickness should be varied in a block pavement in order to achieve a constant level of performance in terms of:

(a) Elastic deflection.

(b) Rutting deformation.

Each of these analyses is now described in more detail.

(a) *Design for a constant level of deflection.* Here the well-known CHEVRON linear elastic computer analysis was used to examine the structure shown in Figure 4a. The load used in this analysis was a single 40 kN wheel with a tyre (contact) pressure of 600 KPa, i.e. corresponding to the maximum legal wheel load for roads in many countries. The purpose of the analysis was to examine the effects of varying the subgrade modulus (and hence CBR) and the basecourse thickness. Before such an analysis can be successfully applied, it is necessary to assign realistic values to the material properties in each layer in the pavement. The values of moduli etc. assigned to each of the flexible material layers were selected from

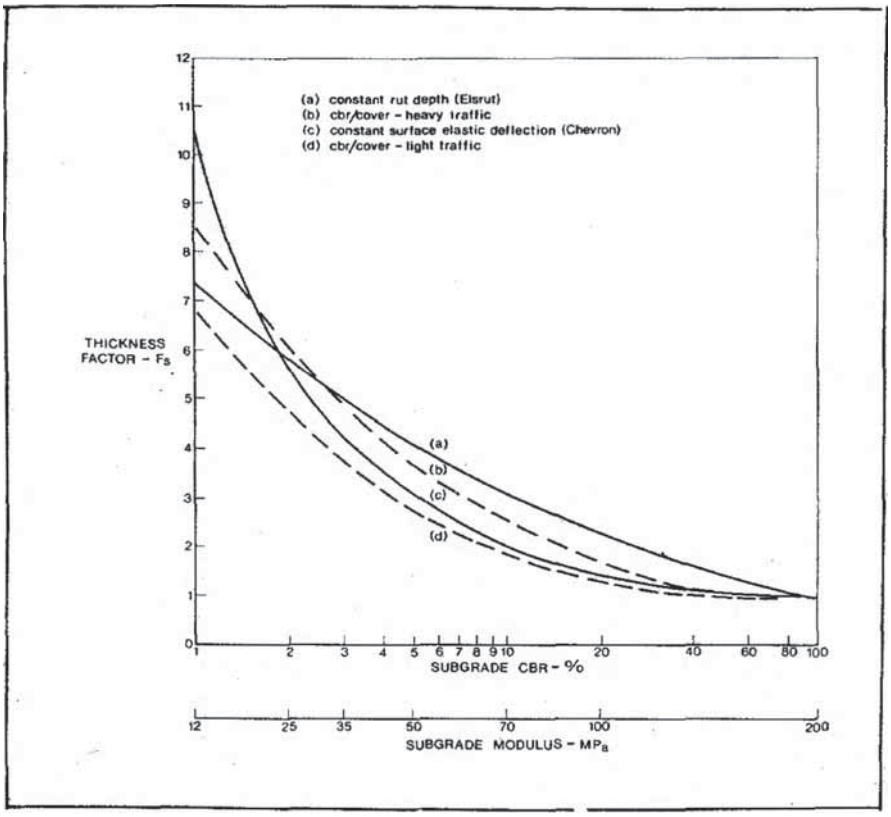


Figure 3: Pavement thickness correction factors

tables of typical values collated by Paterson and Maree[22] from both accelerated trafficking and laboratory tests of actual pavement materials. The selection of suitable values to characterize the paving blocks was more difficult. Values of the apparent modulus of a block layer vary from 415 MPa recently reported by Seddon[10] to 8 000 MPa quoted, apparently without any experimental justification, by Tait[23]. In the analysis described here a value of 900 MPa based on comprehensive tests carried out by Marais[2] was used.

The results of the CHEVRON analysis were rearranged using the techniques of multiple regression to determine how the base thickness should vary in order to maintain a constant level of elastic deflection at the surface of the pavement. This information was then used to plot curve c in Figure 3. Here the relationship between CBR and modulus was based on data given by NAASRA[24], Paterson and Maree[22] and others. It should be noted that the relationship given as Figure 3c is relatively insensitive to changes in the material properties given in Figure 4a and can therefore be used with confidence to cover most practical situations.

Inspection of Figure 3 shows that the thickness factor, Fs, based on the criterion of maintaining a constant level of deflection in the pavement (i.e. curve c) requires the pavement thickness at low CBRs to be rather greater than that given by the conventional CBR/cover relationship (curves b and d). This shows that the criterion of constant deflection is suitably conservative for general use. This is of some importance since it is at low CBRs that it is most appropriate, for economic reasons, to use stabilized bases and sub-bases. As noted above it is necessary to design such pavements in accordance with the criterion of maintaining the deflection within acceptable limits. In other words the design should be based on curve c in Figure 3.

(b) *Design for a constant level of deformation (rutting).* For granular bases, as noted earlier, it is appropriate to base the design on considerations of deformation only. In order to determine how the thickness of a

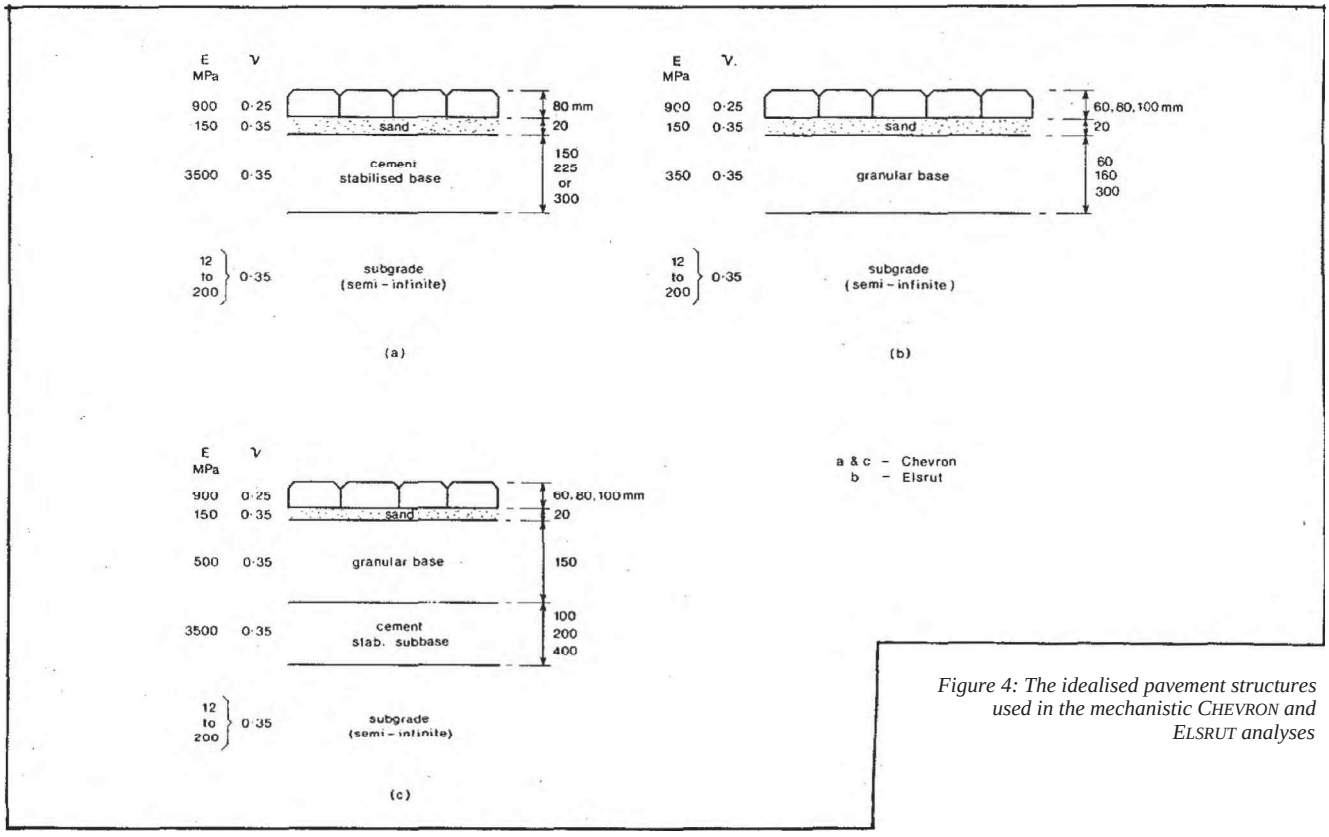


Figure 4: The idealised pavement structures used in the mechanistic CHEVRON and ELSRUT analyses

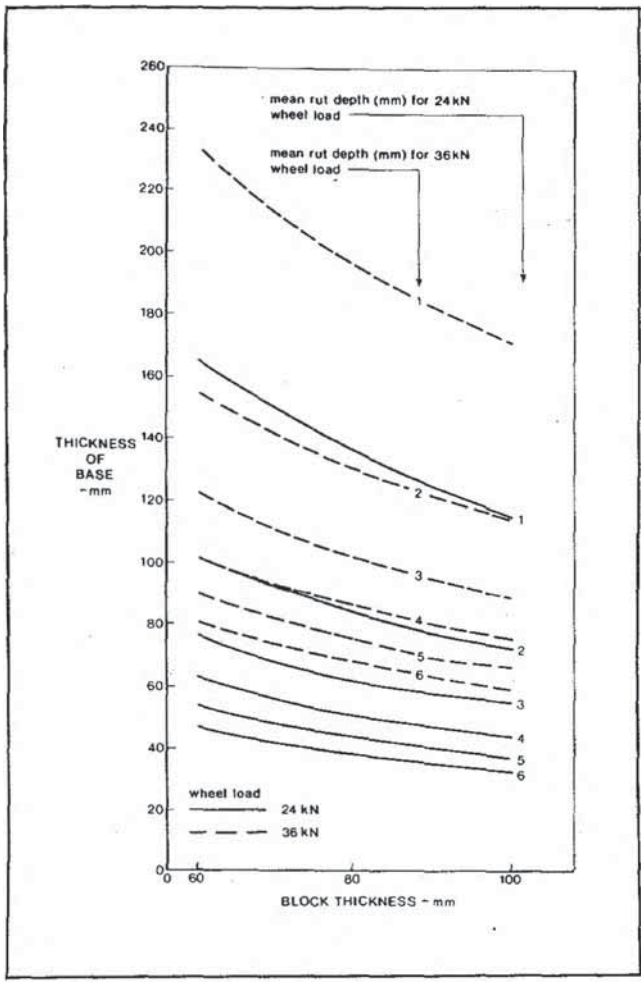


Figure 5: Base thickness as a function of block thickness and rut depth

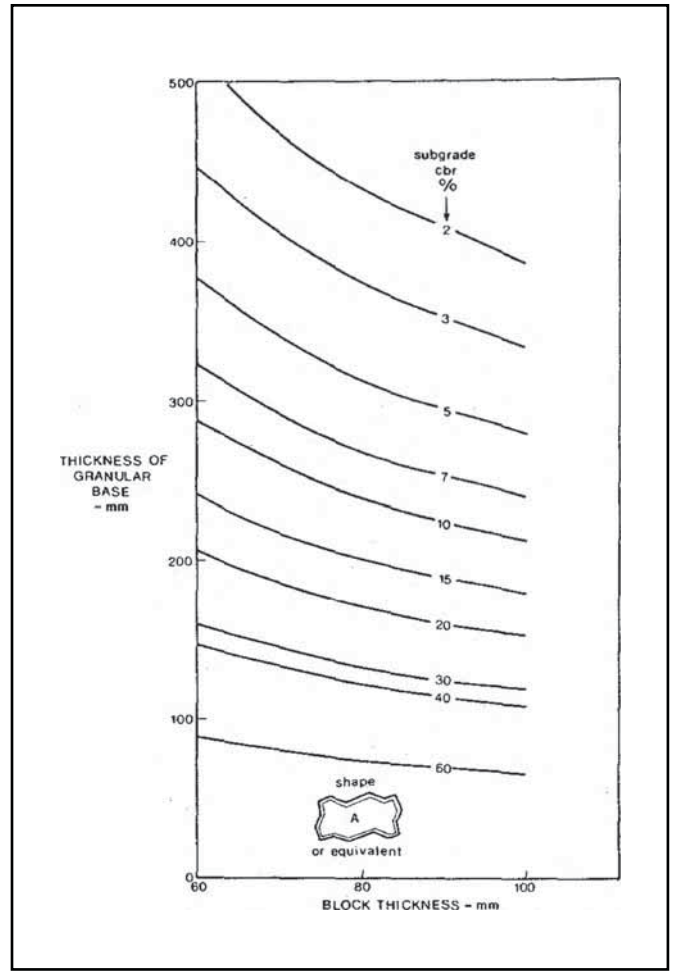


Figure 6: Design nomograph for 6 mm terminal rutting

granular base must be varied in order to maintain the deformation in the pavement constant, the ELSRUT computer program developed at the University of California and described by Freeme and Monismith[25] was used. This program permits the deformation in a pavement resulting from a specified number of load repetitions to be determined. This program was used to compute the rut depth after 10 000 repetitions of a 40 kN single wheel load (tyre pressure 600 KPa) in the pavement structure shown in Figure 4b. As in the elastic CHEVRON analysis described above, the moduli appropriate to the various pavement layers were selected from the values given by Paterson and Maree[22] and Marais[2] supplemented by repeated loading data published earlier by the author[2]*. Again the effects of varying the basecourse thickness and subgrade modulus were evaluated. Then, using multiple regression techniques, the thickness factor/CBR relationship given as the curve a in Figure 3 was obtained.

From Figure 3 it may be seen that the criterion of maintaining a constant level of deformation (rutting) requires greater pavement thicknesses than those given by the CBR/cover relationships (curves b and d) except at low CBRs. Economic considerations will normally restrict the use of granular bases and sub-bases to pavements overlying subgrades of relatively high CBR. Consequently the use of the ELSRUT relationship would seem to be amply warranted in preference to those CBR/cover relationships used in the author's earlier design procedures[13].

The design procedures

The original design curves published by the author[13] were for block pavements incorporating granular materials only. Suitable base materials for this form of construction are expensive. Consequently, it is economically inadvisable to use this form of construction where the subgrade CBRs are low and therefore require substantial pavement thicknesses. For this reason it has been decided to revise the design method to cover three types of pavement structure. The structures and the recommended range of subgrade CBR for which each is thought to be most economical is as follows:

(a) Granular base on subgrade (CBR > 30 %).

(b) Granular base on cement-stabilized sub-base (CBR < 30 %).

(c) Cement-stabilized base and sub-base (CBR < 10 %).

The design methods for each of these categories is now considered in turn.

Design of block pavements with a granular base

As noted earlier, block pavements constructed on granular bases achieve an interlocked condition beyond which neither the wheel load nor the amount of trafficking has any significant influence on the pavement performance. Accordingly it is merely necessary to ensure that the degree of deformation (rutting) that occurs during the early life of the pavement while interlock is developing remains with acceptable limits.

The data plotted in Figure 1 were obtained for prototype pavements in a fully interlocked condition. These data can be rearranged using the techniques of multiple regression to show the thickness of granular base needed beneath various thicknesses of paving block to yield specified degrees of rutting. This is shown in Figure 5. Details of the regressions have been given elsewhere[8,13].

From Figure 5 it is possible to select the combinations of base thickness and block thickness needed to give a specified level of rutting at the development of full interlock for

all pavements constructed on a subgrade similar to that used in the prototype pavements. Here the subgrade CBR was in excess of 60%. For pavements having CBRs below 60% the thickness as given in Figure 5 must be multiplied by the appropriate value of F_s given as curve a in Figure 3.

For convenience the data shown in Figures 3 and 5 can be combined in a single nomograph for the design of road pavements provided a set of suitable design parameters and performance criteria are chosen. As an illustration of this concept Figure 6 has been plotted on the basis of a design single wheel load of 36 kN and a specified rut depth of 6 mm. This degree of rutting is considerably less than that which would be tolerated in actual roads. For example, Paterson[27] quotes acceptable limitingrut depths as ranging from 10 mm on freeways to about 20 mm on lightly trafficked rural roads. For this reason the designs shown in Figure 6 are believed to be conservative.

Design of block pavements with a granular base and cement-stabilized sub-base

The upper limit of thickness of a granular base which is economical varies from country to country but is typically between 150 and 200 mm. Inspection of Figure 6 shows that for subgrade CBRs which are less than about 30% this thickness will be exceeded and it is probable that the pavement costs will no longer be competitive with alternative forms of construction. At this stage the substitution of part of the granular base for a cement or lime stabilized subbase becomes desirable.

As noted earlier once the pavement incorporates a stabilized layer it becomes necessary to consider both the magnitude of the applied load and the number of load repetitions i.e. the amount of traffic in order to ensure that the sub-base will not crack. To determine the thickness of sub-base needed, the pavement structure shown in Figure 4c was analyzed using the linearly elastic CHEVRON computer program. Once more, the properties of the various layers were selected from the data of Paterson and Maree[22] and Marais[2]. The effects of varying the block thickness, sub-base thickness and subgrade modulus on the surface deflection are shown in Figure 7fora 40 kN single wheel load. The elastic (resilient) deflections' of the pavement can be related to the amount of traffic that the pavement will withstand expressed in terms of the number of standard axle loads (E80) using the well known curves published for roads with cement-stabilized sub-bases by Croney[28]. Similarly, as described earlier, the

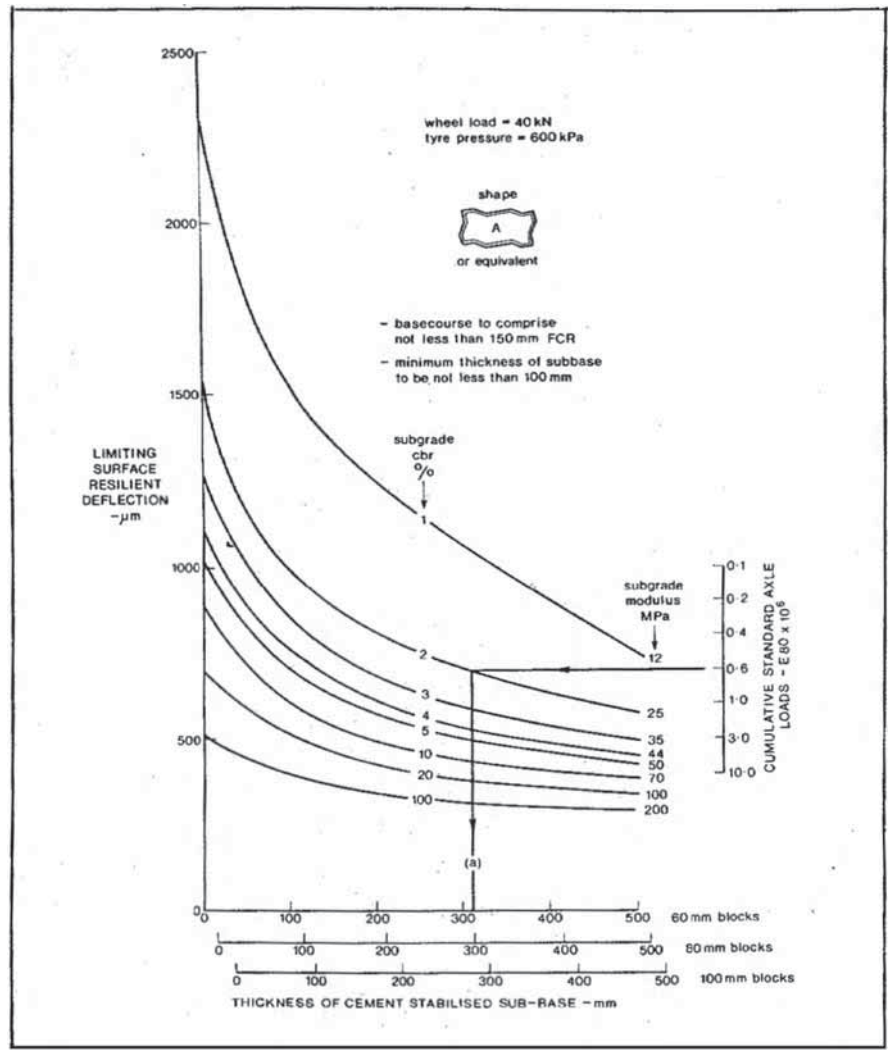


Figure 7: Design nomograph for the selection of the thickness of cement-treated sub-base needed beneath ISO mm of granular base

subgrade modulus can be expressed in terms of the CBR of the subgrade material. Hence Figure 7 can be interpreted as a relationship between traffic intensity (for the maximum legally permitted axle load), subgrade CBR and sub-base thickness and may be used for design purposes (as shown by line (a) on the figure for 0.6 million standard axle loads).

A study of Figure 7 reveals that it is not possible to reconcile the requirements of a high volume of traffic with a low subgrade CBR. In such circumstances some alternative form of construction (e.g. granular base only) should be used. Generally it is believed that the design data given in Figure 7 are conservative although the sub-base thicknesses given are substantially less than those recommended by Tait[23]. In this respect, it should be noted that the relationship between deflection and pavement life assumed in Figure 7[28] was derived for pavements with bituminous surfacings whose tolerance of deflection is much less than that of block pavements. Moreover, the design in Figure 7 assumes that no cracking can be tolerated in the subbase whereas in practice the granular base would act as a barrier against crack propagation disrupting the bond of the paving blocks. *

Design of block pavements with cement-stabilized base and subbase

Here the elastic, deflection of the pavement provides the principal criterion of performance. As reported earlier[7 8], the elastic deflections of block pavements with granular bases appear to be little affected by either the load magnitude or number of load repetitions. Typical data were given in Figure 2. These data may be rearranged by multiple regression techniques to display graphically the relationship between basecourse thickness and paving block thickness for specified levels of elastic or resilient deflection. This is shown in Figure 8.

From Figure 8 it is possible to select the basecourse thickness needed beneath any designated block thickness to yield a specified surface deflection. Again, using the relationships published by Croney[28] it is possible to relate conservatively this deflection to the design life of the

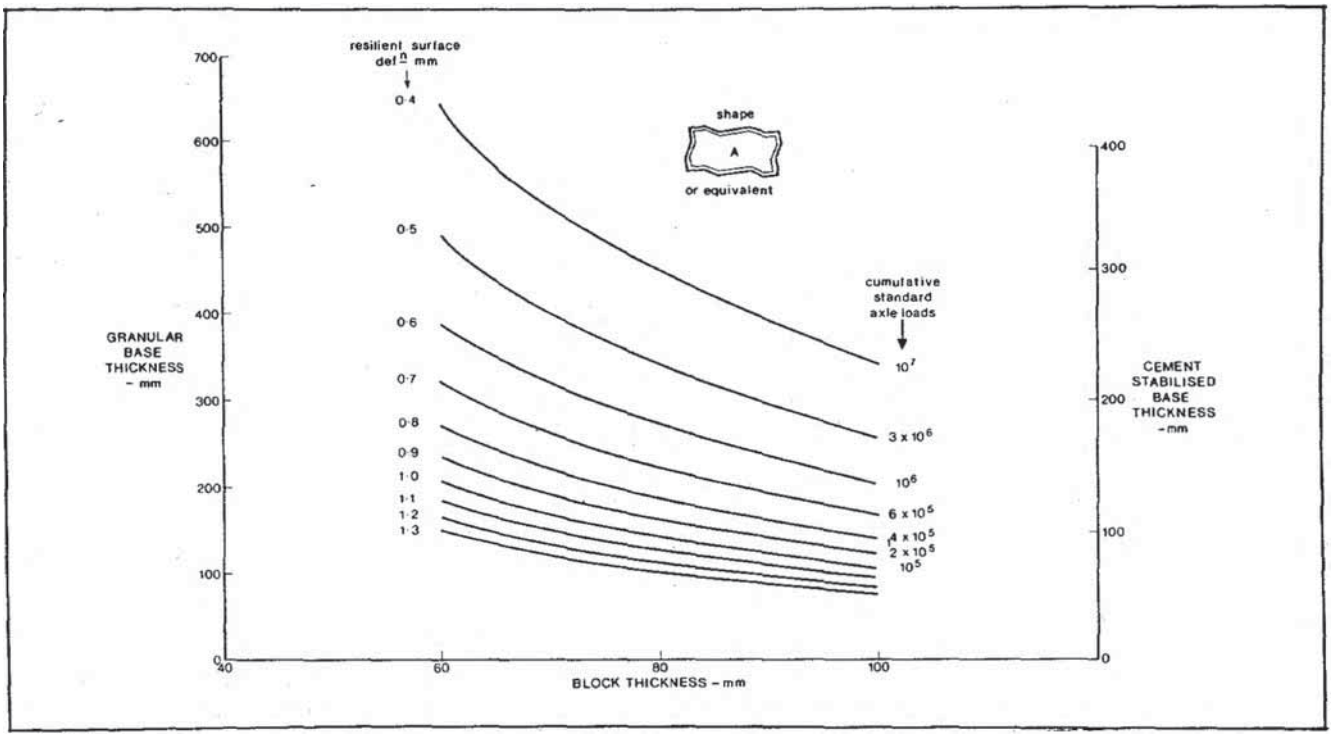


Figure 8: Base thickness as a function of block thickness and resilient deflection

pavement expressed in numbers of standard axle loads. These values have been superimposed on Figure 8.

Figure 8 is plotted in terms of the thicknesses of granular base needed to control the deflection to designated levels. These thicknesses have been converted to equivalent thicknesses of cement-stabilized base by assuming an equivalency factor of 1.5. In other words, it has been assumed that each centimetre of stabilized base is equivalent in performance to 1.5 centimetres of granular base. This equivalency figure is based on the values published in the Australian and draft South African pavement design manuals[24 29]. The validity of this assumption has been checked using elastic deflection as the equivalence criterion by means of a series of CHEVRON computer analyses for a range of base thicknesses and moduli. Within the range of deflections and base thicknesses likely to be encountered in practice the use of an equivalency factor of 1.5 can be shown to be conservative.

Figure 8 can therefore be used with confidence to design a pavement to yield a given design life provided that the subgrade CBR is equal to that used in the prototype pavement (> 60 %). For other values of subgrade CBR the thickness of stabilized

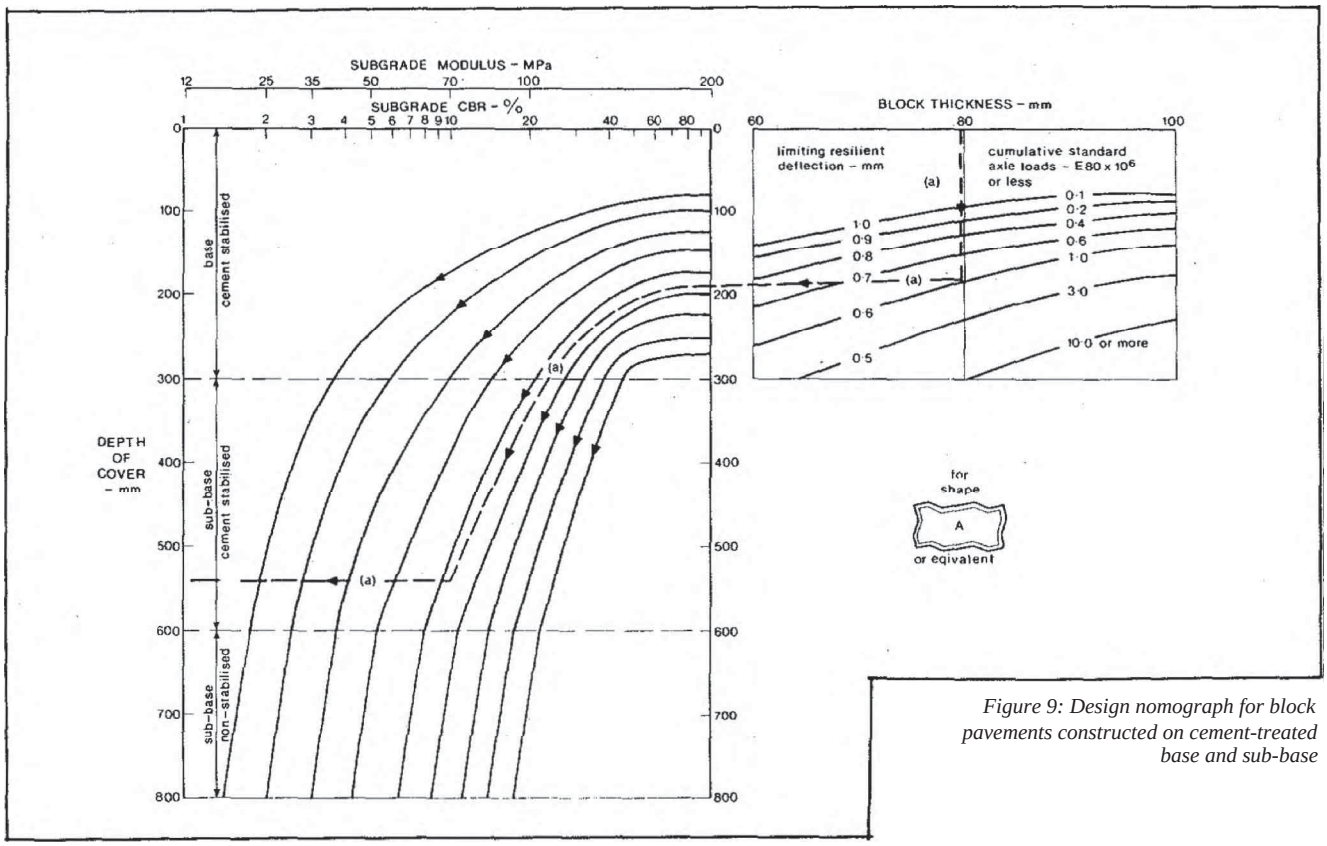


Figure 9: Design nomograph for block pavements constructed on cement-treated base and sub-base

base given in Figure 8 must be multiplied by the appropriate factor, F-, obtained from curve c in Figure 3. Alternatively, Figures 3 and 8 can be combined as a nomograph such as that given in Figure 9. Here it has been assumed that once the base thickness exceeds 300 mm it would be desirable to incorporate a lower quality cement-stabilized subbase. Based on the draft South African pavement design manual[29] an equivalency factor of 1.5 has again been assumed. The line marked (a) on the figure illustrates its use. It may be seen that for a block thickness of 80 mm, a design traffic life of 1 million standard axle loads and a subgrade CBR of 10% the pavement would require 300 mm of cement-treated base overlying 250 mm of cement-treated subbase.

Assessment of the design method

One of the long-term objectives of the current NITRR evaluation of block pavements is to provide verification of existing design methods. At the present stage of testing a full verification is not possible. However, some limited checks on the validity of the author's design method are possible. These supplement the comparisons of design methods published earlier, for granular bases[13].

As noted elsewhere[9], the South African HVS study of block pavements was designed to include some pavement failures. This enables a boundary to be placed on the values of the design criteria. For example, as shown in Figure 10, it is possible to plot the relationship between the wheel loading first applied to the pavement and the in situ subgrade CBR, both for pavements which gave satisfactory performance and for pavements which failed under accelerated trafficking. Here all results have been included irrespective of block shape or laying pattern. It is then possible to sketch a provisional boundary between zones in which failure occurs and zones in which the pavements will probably perform satisfactorily. This is shown in Figure 10. Superimposed on this figure are two design relationships between wheel load and the subgrade strength necessary to support the wheel for the particular block and base thicknesses used in the HVS study[9]. The relationships are based on the work of Marais[2, 30] and on a design equation published in the Argentine by Balado[1]. The relationship inferred from the author's curves (given as Figures 1 and 3) is also shown.

Figure 10 shows clearly that the design procedures derived in this paper are more conservative than those given by either the Argentinian or South African design procedures where the factors of safety appear to be smaller. However, it is important to recognize that each of the three design procedures shown in Figure 10 was derived for a different block shape and that the failure envelope shown in the figure makes no distinction between different types of block. For these reasons Figure 10 should only be regarded as the first approximate check of the design methods and much more testing will be needed before the validity or safety of any design method can be determined with certainty.

Limitations of the design methods

It is important to recognise that the design procedures presented in the preceding sections are based on tests of prototype pavements constructed from blocks having the particular shape shown in Figures 6 to 9 only. Recent tests in South Africa[9] have established that the shape of the

TABLE 1: Recommended minimum standards for base and subbase materials

Property	*Bedding sand*	*Granular base*	*Cement-treated base*	*Cement-treated sub-base*	*Untreated sub-base*
(a) *Particle size distribution*					
percentage passing 53.0 mm	—	100	—		
37.5	—	85-100	100		
26.5	—:	—	84-94		
19.0	—	60-90	71-84		
13.2	—	—	59-75		
9.52	0	—	—		
4.75	95-100	30-65	36-53	Max size	Max size
2.36	80-100	—	—	2/3 layer	2/3 layer
2.00	—	20-50	23-40		
1.18	50-95	16-43		thickness	thickness
600 μm	25-60	—	—		
425-	—	10-30	11-24	or 63 mm which-	
300	10-30	9-27	.—	ever is smaller	
150	5-15	—	—		
75	0-10	5-15	4-12		
(b) *Plasticity*					
Liquid limit (max) %		25	—	—	—
Plasticity index (max) %	non-plastic	6	6	6	12
Linear shrinkage (max) %		3	—	—	—
(c) *Strength*					
Unconf, comp, strength (MPa)	n/a	—	1.5 (min) 3.0 (max)	0.75 (min) 1.5 (max)	—
10% FACT (min)	n/a	60 kN	100kN	—	—
ACV (max)	n/a	—	20%	—	—
Soaked CBR at 95% mod. MDD	n/a	80%	—	—	45%
Max swell at 100% mod MDD	n/a	0.5%	—	—	0.5%
(d) *Compaction*					
Min % mod. AASHTO MDD	n/a	98%	97%	95%	95%

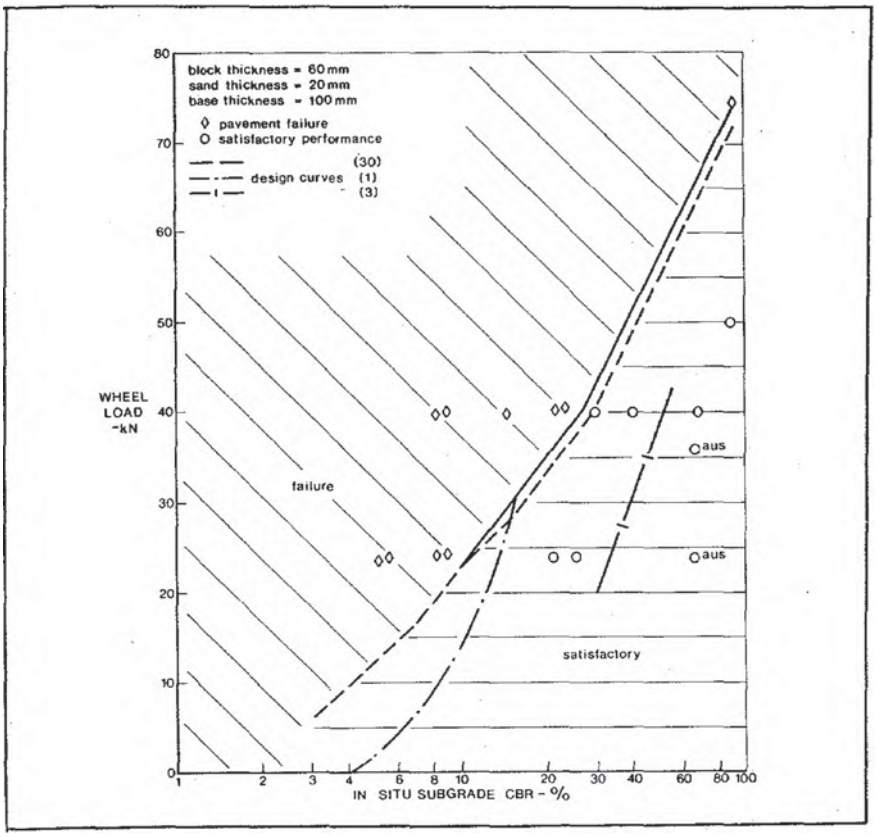


Figure 10: Relationship between wheel load and subgrade CBR necessary for support

paving block can profoundly influence the level of performance achieved under traffic. Accordingly, where the shape of a paving block differs markedly from that shown in Figures 6 to 9, the design data should be treated with caution.

When using the design methods given here it is important to use materials whose quality is at least equal to that used in the various accelerated trafficking tests. A list of the minimum recommended standards to be achieved in each layer of the pavement is given in Table 1.

Concluding comments

This paper attempts to formulate a set of soundly-based design curves for interlocking concrete block pavements. The design procedures are based primarily on tests on full-scale block pavements subjected to accelerated trafficking. The data from these tests have been incorporated in conservatively based mechanistic analyses to produce the design nomographs presented here. An extensive series of tests designed to validate the design procedures is currently being undertaken but is not complete. Nevertheless, a limited comparison of the design methods presented here with those already established suggests that they will yield conservative results.

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